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NEW TRENDS IN TECHNOLOGY, AND THEIR APPLICATIONS: HYDROGRAPHY

The Coast and Geodetic Survey's nautical chart rescheming plan

Paper submitted by the United States of America**

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** Prepared by John A. Miller, Howard P. Danley, Kirby A. Gean, Lynn West, Eugene M. Page, Nautical Charting Division, Coast and Geodetic Survey, National Ocean Service, NOAA, Silver Spring, Maryland 20910-3233.

INTRODUCTION

The origins of the Coast and Geodetic Survey (C&GS), a component of the National Ocean Service, National Oceanic and Atmospheric Administration (NOAA), dates to an 1807 Congressional resolution authorizing the President to "...cause a survey to be taken of the coast of the United States, and of the outlying islands and shoals...". After many delays, Ferdinand Hassler, the first superintendent of the Coast Survey (as it was known then) produced the Survey's first nautical chart in 1839, depicting Newark Bay.

Since that time many of the existing C&GS nautical charts, which now number nearly one thousand, were originally planned and produced on an individual, single purpose basis without overall consideration of adjacent coverage or a coordinated area plan. This resulted in the current use of more than two dozen different scales, four different projections, and a variety of paper sizes. In some areas of the U.S., notably Alaska, chart coverage is of a scale too small to adequately serve the requirements of expanding shipping, fishing, and military interests.

MCB has identified three C&GS nautical charting parameters for improvement:

1. Standardize the scales of charts in accordance with international specifications.

Standardizing scales will improve mariner's transitions between adjoining C&GS charts, improve transitions to charts of the Defense Mapping Agency Hydrographic/Topographic Center and Canada, and eliminate odd scales such as 1:210,668 (C&GS Chart 18680).

A coastal charting series of 1:100,000-scale and 1:250,000-scale has been designed for the entire U.S. This new coastal series will facilitate route planning and resource management along the U.S. coasts, and is similar in idea to the standardized topographic series of U.S. maps produced by the U.S. Geological Survey.

2. Standardize chart paper sizes, using the international standards of A0 or derivative sizes.

The International Hydrographic Organization (IHO), of which the U.S. is a member, actively promotes the uniformity and compatibility of hydrographic documents, and the free exchange of

hydrographic chart reproduction materials between member countries. Some countries are not equipped to handle the larger chart sizes currently produced by C&GS. The IHO has recommended the use of A0 paper size as the standard for nautical charts. Standardization of paper sizes will facilitate the exchange of chart reproduction materials.

3. Standardize chart projections.

NOS currently uses four projections for nautical charts:

- Lambert Conformal Conic
- Mercator
- Polyconic
- Universal Transverse Mercator

IHO standards require 1:50,000 and smaller scale charts to be constructed with a Mercator projection. A number of C&GS charts, primarily in the Great Lakes, do not meet this requirement. By reducing the number of projections in use, chart construction techniques will become more unified and easier to manage.

What goals will be accomplished by modernizing C&GS nautical charts?

- The reduction in the number of total charts.

This could be accomplished by standardizing scales (i.e. changing the current 1:40,000 and 1:80,000-scales to 1:50,000 and 1:100,000-scales). However, any reduction in the number of charts by changing scales may be offset by the additional charts required in the new 100,000 and 250,000-scale coastal series.

- The incorporation of requests for changes to the nautical charts by mariners in the private and government sectors.

MCB has kept records of chart user's comments, requests, and complaints about C&GS nautical charts since the 1970s. A weighting algorithm was developed in the 1980s to rank requests and assign resources to new or revised chart construction. Currently, there are over one thousand requests for changes or new charts on file. Limited yearly resources allow for work by MCB on only a fraction of the requests.

During the modernization process, the chart request file will be accessed, and new charting schemes will be developed to accommodate as many requests as possible.

- International standardization.

Meeting IHO standards will ensure that C&GS nautical charts continue to be accepted and used by the international maritime community. Transitions between international and C&GS charts will be easier.

- Cartographic simplification.

Cost savings in compilation may be realized by reducing the number of scales and projections. Charts will be more uniform in appearance and size, and transitions between adjoining charts will be simpler.

RESCHEMING METHODOLOGY

A new PC-based program, called RESCHEME, has been developed within the Nautical Chart Division to assist in designing new and reconstructed chart layouts. RESCHEME is essentially a DBASE III sub-routine, and draws upon the formats of the older MCB CHAPP FILE. The CHAPP FILE (Chart History and Plotting Parameters) is a DBASE data file that contains complete plotting and construction parameters of every C&GS nautical chart. The file contains information such as the title, scale, projection, central latitude and longitude, and geographic positions of all chart corners. RESCHEME creates a CHAPP-like data file format. The program user must input the following information:

- For A0-sized charts; scale, central latitude and longitude, orientation (the orientation of the long axis of the chart; either north-south or east-west). The geographic positions of the corners of the new chart are then calculated and stored.

- For other sizes or insets; scale, latitude and longitude of each corner.

The program user can access the RESCHEME file through DBASE III to enter titles, chart numbers, change projections (the default projection is the Mercator Projection), and manipulate any of the individual records as necessary.

In practice, the chart planner rescheming a particular area uses an existing small-scale paper chart to begin the layout. Templates are made out of mylar or paper, at the correct scale and paper size, and a rough layout is penciled onto the chart. The planner identifies and records the geographic center of each rectangle (or the corners, for odd-sized charts or insets) and the orientation of the long axis. The planner enters this information into program RESCHEME, choosing either the A0 paper option or the inset/other size option.

To view the calculated results of the RESCHEME file, the chart planner must access a second program also developed within the Nautical Chart Division, called FPLOT. FPLOT is a PC-based program, and has the capability of plotting the neatline of the new chart(s), the projection grid, title, and chart number, on the computer monitor. The chart planner can quickly check adjoining chart overlaps and, by accessing the optional shoreline plotting routine, check that bays, harbors, and waterways are fully covered within the appropriate neatlines. FPLOT can also superimpose point information and draw a number of different mapping symbols by accessing optional geographic DATABASE files.

FPLOT utilizes a CALCOMP 1026 drum plotter or MCB's KONGSBERG flat bed plotter for full-scale plots on mylar or paper. Modifications to FPLOT are currently under development to allow reduced plotting to Canon and Hewlett-Packard laser printers.

FPLOT draws correctly-sized neatlines of the new charts onto a mylar base chart. The chart planner can then overlay the mylar onto the paper chart, checking that the new chart neatlines include relative navigational aids and landmarks.

If shifts are necessary to a particular neatline, the chart planner can scale a new center latitude and longitude (or corner positions), change the limits through program RESCHEME, and obtain new plots.

FPLOT does not allow on-screen text modification or changes. However, FPLOT generates a .DXB file that can be imported into AUTOCAD. Recent experiments have successfully added text, shading, and colors to the plots, enhancing the graphic representations.

Benefits of the RESCHEME and FPLOT programs are:

- New charts or changes to the limits of existing charts can be quickly developed and modified in the PC environment.

- New chart parameters are stored in DBASE file format, providing storage for future manipulation or changes. Once a scheme has been approved for production, files can be accessed to provide geographic positions of corners and other chart specifications for the MCB cartographic teams.

- Atlases or presentation plots can be quickly made for review by C&GS personnel or other government agencies or interested parties.

FUTURE DEVELOPMENTS

In the future, MCB anticipates using scanned nautical chart imagery as a backdrop to newly developed schemes. The outlines of new charts, generated by program RESCHEME, will be displayed on the monitor in accurate geographic positions against the chart backdrop, thus eliminating or reducing the need for rough drafts on paper. Incorporating scanned imagery with proposed chart schemes provides an excellent stage for pre-planning tasks and allows a PC environment for all planning work to be performed.

RESCHEMING STATUS

A new 1:100,000 and 1:250,000-scale draft scheme of charts has been developed for all of the U.S. coastline except the Great Lakes. Much of the Gulf and east coast areas have larger-scale rescheming coverage completed in draft form on paper charts, but have yet to be entered into DBASE files. Rescheming of other areas of the U.S. continues on a part-time basis. Completion of the rescheming effort is estimated to take 1 or more years.

CONCLUSION

MCB recognizes that improvements are necessary to the C&GS suite of nautical charts to continue to provide high quality charting products and meet the changing needs of government and

private maritime interests. A reduction in the number of chart scales and projections and the use of A0-size paper will help C&GS meet international charting standards. An active chart rescheming program is underway by MCB. When completed, the plan will provide a basis for improving area coverage, improve overlaps and transitions between charts, and will become a guide to new chart layouts in the future. To aid in the rescheming process the Nautical Chart Division has developed PC-based software and plotting routines that has reduced chart planning time. In the future, MCB will utilize scanned C&GS nautical charts to reduce or eliminate the need for planning new charts on paper copies.

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